Heisenberg vortex for light-weight refrigeration of liquid hydrogen

Completed Technology Project (2016 - 2018)

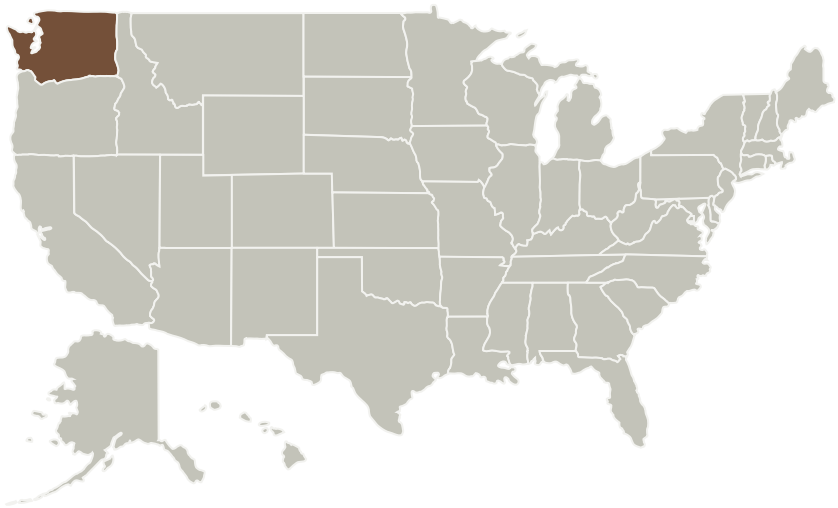
Project Introduction

Only 83 years ago Werner Karl Heisenberg was awarded the Nobel Prize in physics. His work led to the creation of quantum mechanics, the application of which has, inter alia, led to the discovery of the allotropic forms of hydrogen. Fast forward to today, and the idea that a device as simple as a tube could allow further space travel than ever before seems impossible. Yet, this is exactly what the Heisenberg vortex allows. The novel Heisenberg vortex allows for a completely new strategy for the refrigeration of liquid hydrogen tanks. The para-orthohydrogen conversion via the Heisenberg vortex consists of a Ranque-Hilsch vortex tube with catalytic liner and takes advantage of the largest entropy change useful at cryogenic temperatures. This invention will have a direct impact on NASA TABS 14.1 Cryogenic Systems technology area. Specifically, this technology will address in-space propellant boil-off. Complex cryocoolers are currently used for refrigeration due to liquid hydrogen's very low temperature requirements. But, these systems are heavy, power intensive, and contain many moving parts. The Heisenberg vortex has the potential to supersede current cryocooler technology resulting in an efficient, reliable refrigeration system with no moving parts and lightweight characteristics. This advance is directly relevant to the Evolvable Cryogenics (eCryo) and the Advanced Cryogenic Evolved Stage (ACES) projects. This project will be a continuation of the great NASA relationship established here at the HYPER Lab and Washington State University.

Anticipated Benefits

Specifically, this technology will address in-space propellant boil-off.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Washington State University	Lead Organization	Academia	Pullman, Washington

Primary U.S. Work Locations
Washington

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Washington State University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Jacob Leachman

Co-Investigator:

Carl D Bunge

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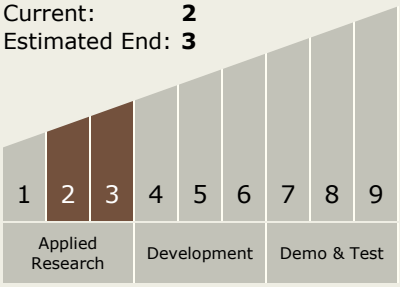
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.1 In-space Propellant Storage & Utilization

Target Destinations

The Moon, Mars, Others Inside the Solar System